PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements relating to apparatus and methods for Mounting Anatomical and like specimens

I, JAMES BENJAMIN MCCORMICK, a citizen of the United States of America, of 521, South Madison Avenue, LaGrange, Illinois, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to mounting anatomical specimens, tissues and cell structures for use in biological studies, particularly for medical work in hospital laboratories.

The object of the invention is to provide an improved apparatus and method for mounting and preparing such specimens and tissues to obtain new and beneficial results with respect to such matters as (1) accuracies in the resultant specimens as a factor in avoiding errors in diagnosis, (2) economies in the making of these impressions, (3) simplicity in the actual operations, and (4) a new technique in the operations which enables the keeping of accurate records of the specimens.

According to the present invention, an apparatus for embedding a specimen in a body of paraffin or other wax for mounting in a microtome to enable a thin sheet containing a part of the embedded specimen to be sliced from the body comprises a base mould having bottom and side walls and an open top, the bottom wall of the mould serving to support a specimen and the bottom and side walls serving to define the shape of the finished wax body when hardened after molten wax has been poured into the mould through the open top thereof for embedding the specimen, and an open mould arranged to seat on top of the base mould and having side walls which define an opening through which the wax is poured into the moulds to a level reaching into the open mould, the side walls being of irregular shape on their inner surfaces so that when the wax hardens it will be united to and cannot be removed from the open mould without breaking either, the base mould being removable from the moulded wax body, the open mould and the moulded wax body constituting a finished assembly having at one end the open mould which provides a permanent wall structure adapted to be clamped in the microtome and having at its opposite end the moulded wax body containing the embedded specimen, whereby the assembly supports the embedded specimen in the microtome for slicing.

This apparatus gives rise to a new method of embedding a specimen in a body of paraffin or other wax preparatory to slicing the body and specimen in the microtome. The method includes the steps of placing the specimen on the bottom of an open topped base mould, placing on top of the base mould an open mould which provides an opening through which molten wax is to be poured into the mould and which has side walls that are of irregular shape so that when the wax hardens it will be united to and cannot be removed from the open mould without breaking either, pouring the wax through the opening to level within the open mould sufficient for embedding the specimen in the mould and for uniting the wax to the open mould when the wax hardens, and removing the base mould from the hardened paraffin body.

An apparatus in accordance with the invention and a method of mounting specimens using this apparatus will now be described, by way of example only, with reference to the accompanying drawings, in which: —

Figure 1 is a perspective view as seen

from above of upper and lower parts of a mould with the parts separated;

Figure 2 is a perspective view of the same parts as seen from below;

Figure 3 is a cross-section through the lower mould part on the section line 3—3 of Figure 1 showing a specimen positioned within the lower box part;

Figure 4 is a similar section but showing the upper mould part positioned on top of the lower mould part for pouring the paraffin wax;

Figure 5 is a similar section showing the paraffin wax after it has been poured through the open top of the assembled mould parts;

Figure 6 is a section through the assembly comprising the embedded specimen and the upper mould part after the lower mould part has been removed;

Figure 7 shows the finished assembly clamped between the jaws of a microtome with the projecting embedded specimen in position to be sliced by successive slicing operations to obtain individual specimen slices suitable for use with diagnosing equipment;

Figure 8 shows the manner in which the upper mould part may be used with any of a number of lower mould parts of different sizes or capacities;

Figure 9 is a diagrammatic perspective view showing the finished assembly clamped in the microtome, the slicing knife, and a series of specimen slices cut in succession;

Figure 10 is a perspective view of a finished assembly showing an embedded tumor specimen in connection with the study of specimens successively cut from the paraffin wax block;

Figure 11 is a perspective view of a first specimen cut from the block shown in Figure 10;

Figure 12 is a perspective view of an upper mould part showing a case identification surface on a wing portion of the mould.

The two part embedding mould illustrated consists of lower and upper mould or box parts designated generally by 10 and 11 respectively. The lower box part is essentially a base mould and the upper box part an open mould member having side walls but being open at the top and bottom. The lower box part has a bottom wall 12 and side walls 13, the inner face of each side wall 13 being slightly tapered to provide draft for easy removal from the embedded paraffin wax body as will be presently apparent. The upper box part has side walls 14 which provide an opening for pouring the paraffin into the lower box part. The upper box is shaped to seat on the lower box part and is provided with suitable positioning lugs 15 which fit inside the bottom box part at four sides thereof and locate the upper box part in proper relation to the lower part. The upper part has laterally extending flanges 16 which are of suitable length to cover lower box parts of different sizes, as will presently be described. The upper box part is also provided with an interior configuration such as internal ribs 17 adapted to be embedded in the paraffin wax to retain the moulded paraffin wax in the upper part. The upper box part is moulded of high impact styrene. The lower box part is of aluminium or other material having a greater coefficient of heat transmission than that of the upper box part and also of the paraffin wax. With this combination the heat exchange from the aluminium box part is more rapid than from the upper box part, thereby causing the paraffin wax within the aluminium mould to cool at a more rapid rate than the paraffin confined within the upper box part. The net effect of the cooling of the paraffin wax in this assembly is that the shrinkage pattern extends downward into the aluminium mould and produces a full impression of the paraffin against the bottom and side walls of the mould. This produces an impression with the specimen in a flat or plain surface at the face of the moulded paraffin wax body and ensures a flat initial sectioning of the tissue to be studied. Also it produces full parallel side walls and definite rectilinear edges on the moulded paraffin wax body, the purpose of which is described below with relation to the finished assembly and the support of the assembly in a microtome for slicing.

To effect certain economies lower box parts of different sizes are provided to accommodate a range of specimens to be studied in hospital laboratories but only a single size upper box part is provided which will coact with any of the different sizes of lower box parts. As an example, the lower box part 10 shown in Figures 1 to 5 inclusive is the $\frac{7}{8}$" size. This has a square mould cavity measuring $\frac{7}{8}$" between the inner faces of opposite side walls 13. Figures 1 and 2 show the box parts approximately full size. Figures 3, 4 and 5 show the $\frac{7}{8}$" size box parts enlarged. Figure 8 shows fragmentary views of $\frac{5}{8}$", $1\frac{1}{4}$" and $1\frac{1}{2}$" sizes of lower box parts, each coacting with the single upper box part 11. The largest size lower box 18 has a length and width corresponding with the length and width of the upper box 11 so that the latter seats on the top of the side walls of the lower box part. A small nipple projection 15[1] provided on the underside of each extension 16 serves to engage inside the side wall at each end of the largest lower box part 18, locating this box part against longitudinal displacement. Lateral displacement is prevented by the depending flange 15 on the upper box part which fits inside the side walls of the largest lower box part. The $1\frac{1}{4}$" size is measured between the inner sides of end walls 20 and each end wall is pro-

vided with a locating recess to receive the adjacent nipple projection 15'. The smallest size lower box part 21 has a mould cavity $\frac{5}{8}''$ square. In this size the side walls of the lower box part are extended laterally at the top and terminate in an upturned marginal flange 22. The marginal flange 22 fits outside the positioning lugs 15 which as shown in Figure 2 extend continuously around the square opening in the upper box part. Thus the fit between the flanges 22 and 15 locates the box parts in registration and against displacement laterally. The end flanges 16 on the upper box part are of sufficient length to cover the open top of the larger lower box parts for the $1\frac{1}{4}''$ and the $1\frac{1}{2}''$ sizes. Each lower box part has laterally extending tabs 23 located centrally between the ends and flush with the top surface of the part, as shown in Figure 1. These tabs project beyond the sides of the upper box parts when the box parts are assembled. After the paraffin wax has hardened with the specimen embedded therein, as described below, the lower box part is separated from the moulded paraffin body by thumb engagement with the tabs or by inserting a thin blade instrument between one of these tabs and the bottom edge of the upper box part. Each upper box part becomes an integral part of the finished assembly which includes a paraffin wax embedded specimen. The lower box part which serves as the base mould for casting the specimen is intended to be repeatedly used with any of the upper box parts.

Laboratory procedure is as follows: The lower box part 10 is placed open side up on a suitable support and a specimen indicated by 23*a* is placed within this box part resting on its bottom 12. Having thus positioned the specimen, the upper box part 11 is then placed on the lower box part in the manner shown in Figure 4. Melted paraffin wax is then poured into the box structure through the open top of the upper box part and the paraffin wax is allowed to come above the internal projections 17 of the upper box part, completely embedding the specimen and so retaining it. The paraffin wax is then allowed to cool. By reason of the above described difference in the coefficient of heat transmission between the upper and lower box parts, together with the physical properties of the paraffin wax an important new function is produced. Paraffin or other wax such as is used most frequently in this practice, when in a molten state at approximately 50 to 60 degrees centigrade has an increase of volume of approximately 10% over its solid state. When the paraffin cools the shrinkage of the paraffin moves in the direction of the greatest heat exchange; consequently in casting into the lower box which has the greater coefficient of heat transmission the shrinkage moves toward the sides and bottom walls of the box or mould, thereby insuring full and firm impression of the wax against these walls and providing the desired flat surface 30 and reference edge 31 noted in Figure 9. Resulting from this shrinkage is the meniscus 24 shown in Figures 5 and 6. The paraffin wax need not completely fill the upper box part. It is sufficient merely to fill to a level above the internal projections 17 to insure the desired undercut interlocking between the upper box part and the paraffin wax when the latter hardens. Thus a considerable saving in paraffin is obtained.

The lower box part may now be removed from the moulded paraffin body leaving the finished assembly consisting of the integrally connected upper box part and the moulded paraffin body. This assembly may now be placed between jaws 26 of a microtome in the manner shown in Figures 7 and 9. By inserting this assembly between the microtome jaws until the flange 16 contacts the outer ends of the jaws and the jaws clamp against the outer faces of the flat walls 14, the unit is located and held in a predetermined position for the purpose of holding the face 30 of the paraffin wax body and its edge 31 (Figure 9) exactly parallel with the plane in which the cutting blade moves. The microtome jaws engage only against the rigid and definitely shaped outer faces of the upper box part and this contact engagement is not with the paraffin itself or with any supplemental part. Thus the unit is accurately and firmly clamped in position for the shaving or slicing operations. Figure 9 is a more complete illustration of a conventional microtome head 32 and its hand screw 33 for moving one of the jaws 26 in clamping and releasing movements. Each time a finished assembly is mounted in the microtome its face 30 will be supported in a predetermined plane with relation to the face of the microtome. Likewise the edge 31 of the paraffin wax body will be accurately supported in predetermined relation to the face of the microtome and also to the cutting edge 34 of the reciprocating knife 35. The edge 31 is supported in exact parallelism with the cutting edge 34 of the knife and the latter moves in a plane exactly parallel with the face 30 of the paraffin wax body. Under these conditions the slice from the paraffin wax body will be of uniform thickness throughout. Also successive slices 35*a*, 36 and 37 will be of ribbon form because of the fact that the trailing edge 38 of each slice is retained on the edge of the knife and upon the next succeeding stroke of the knife this edge 38 will register with the edge 31 of the paraffin body throughout the length of these edges and will be joined one to the other by the pressure of the advancing slice.

This not only facilitates the handling of the specimen slices but it is most important in the serial study of specimens.

Attention is directed to the accuracy with which any embedded specimen may be repositioned in the microtome for obtaining specimens having precise predetermined relationship to previously sliced specimens. This is extremely important as a factor in avoiding error in diagnosis. For example, one of the characteristics of malignant tumor tissue is its ability to invade by infiltration the adjacent normal tissue. In studying tumor it is frequently this criteria of tissue invasion that differentiates between a benign growth and a malignant growth. An illustration of this phenomenon would be in malignant tumors of the thyroid gland where the tumor tissue might appear benign in its cellular detail but the evidence of invasion of a vascular structure would be interpreted as indicating a malignant change. In studying such a condition in an area wherein tumor cells lie adjacent to a blood vessel the suspicion of infiltration of tumor cells would be aroused. This suspicion would be followed by a request for repeat specimens from the same area to determine whether forward growth of the tumor went through the vessel wall and invaded a normal tissue. It is here extremely important to be able to recut the original specimen in precisely the same plane of sectioning so as to reveal the true progress of the particular area. Such a condition is shown somewhat diagrammatically in Figures 10 and 11. Figure 10 shows such a tumor specimen designated generally by 39 embedded in a paraffin wax body 41. Figure 11 shows a first specimen slice 42 removed in the manner described. Examination of this specimen through the microscope reveals at point 43 an area of suspicion where the tumor tissue 39 appears to be growing close to the blood vessel 44. This suspicion prompts the pathologist to study additional sections of the tumor tissue through precisely the same reference plane. Because the specimen body would be likely to have been removed from the microtome for storage or to give way to the taking of slices from other specimens, it is necessary to remount the assembly having the paraffin body 41 and to make additional cuttings such as 45, 46 and 47, as the case may be. By reason of the accurate positioning of the paraffin wax body with the face precisely in the same predetermined plane with respect to the cutting blade as described above each specimen will be cut with precision in a plane parallel to that in which the previous slice was cut. Thus a study of the successive sections will reveal the tumor tissue infiltrating this blood vessel as in the area 48 of successive specimen slices 45, 46 and 47. This procedure which is predicated essentially on remounting the paraffin body precisely with relation to a predetermined reference plane definitely helps to avoid the chances of error in interpretation inherent in previous methods.

Previous methods have also involved intrinsic error due to failure of preserving identification of the embedded specimen. Usually a small piece of paper or cardboard containing the identification marking is attached to the paraffin wax block in which the specimen is embedded, using a hot spatula for melting the paraffin at the point of attachment to the block. Not infrequently these paper identifications come loose and the block no longer is properly identified. This is particularly true where the paraffin blocks are stored somewhat promiscuously in boxes usually of odd sizes collected around the laboratory. This invention avoids this trouble by utilizing the upper box part as a permanent means of identification. Preferably an exterior surface of this box part is etched to provide a surface suitable for marking the desired identification date with a graphite pencil. In Figure 1 such a surface is indicated at 28. In Figure 12 the face 49 of one or both of the flanges or wings 16 is etched or suitably treated for marking. This identification is further preserved by storing the finished assemblies in shallow drawers having partitions for holding the assemblies in rows with the identification end uppermost and facing to the front. Because all the finished assemblies are of the same overall length and width irrespective of the four sizes of lower box parts or moulds herein disclosed, they may be uniformly stacked one against another in horizontal rows with the markings facing forward.

WHAT I CLAIM IS:—

1. An apparatus for embedding a specimen in a body of paraffin or other wax for mounting in a microtome to enable a thin sheet containing a part of the embedded specimen to be sliced from the body, the apparatus comprising a base mould having bottom and side walls and an open top, the bottom wall of the mould serving to support a specimen and the bottom and side walls serving to define the shape of the finished wax body when hardened after molten wax has been poured into the mould through the open top thereof for embedding the specimen, and an open mould arranged to seat on top of the base mould and having side walls which define an opening through which the wax is poured into the moulds to a level reaching into the open mould, the side walls being of irregular shape on their inner surfaces so that when the wax hardens it will be united to and cannot be removed from the open mould without breaking either, the base mould being removable from the moulded wax body, the open mould and the moulded wax body

constituting a finished assembly having at one end the open mould which provides a permanent wall structure adapted to be clamped in the microtome and having at its opposite end the moulded wax body containing the embedded specimen, whereby the assembly will support the embedded specimen in the microtome for slicing.

2. Apparatus according to Claim 1, in which the base mould is of a material having a coefficient of thermal conductivity greater than that of the open mould whereby the shrinkage of the wax when cooling moves toward the bottom and side walls of the base mould to ensure full impression of the wax body against the walls.

3. Apparatus according to Claim 1 or Claim 2, in which the irregular shape of the inner side of the side walls of the open mould is formed by an interior peripheral wax retaining collar which extends inwards from the side walls and serves to lock the wax body to the open mould.

4. Apparatus according to any one of the preceding claims in which the open mould is provided with a surface for identification marking.

5. Apparatus according to any one of the preceding claims, in which the open mould has flange-like extensions at opposite ends adapted to cover the open tops of similar base moulds of larger sizes, whereby one open mould may be used with any of a number of base moulds of different sizes.

6. The method of embedding a specimen in a body of paraffin or other wax preparatory to slicing the body and specimen in a microtome, including the steps of placing the specimen on the bottom of an open topped base mould, placing on top of the base mould an open mould which provides an opening through which molten wax is to be poured into the moulds and which has side walls that are of irregular shape so that when the wax hardens it will be united to and cannot be removed from the open mould without breaking either, pouring the wax through the opening to a level within the open mould sufficient for embedding the specimen in the mould and for uniting the wax to the open mould when the wax hardens, and removing the base mould from the hardened wax body.

7. Apparatus according to Claim 1, constructed substantially as described with reference to Figures 1 to 5 of the accompanying drawings.

8. A method according to Claim 6, substantially as described with reference to Figures 1 to 8 of the accompanying drawings.

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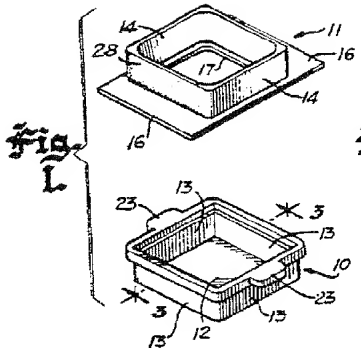

Fig. 1

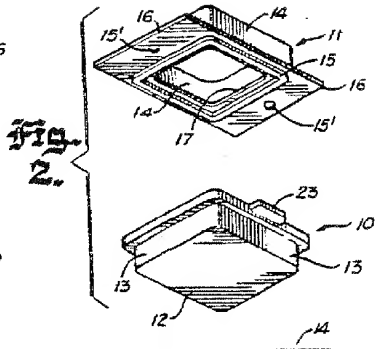

Fig. 2

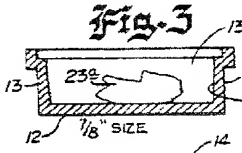

Fig. 3

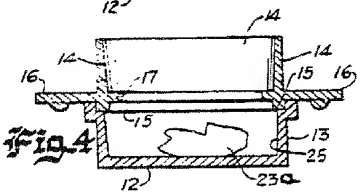

Fig. 4

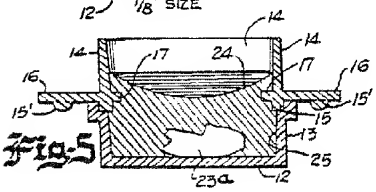

Fig. 5

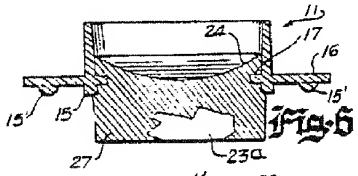

Fig. 6

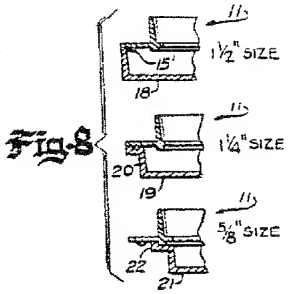

Fig. 8

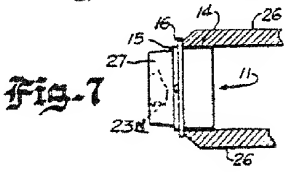

Fig. 7

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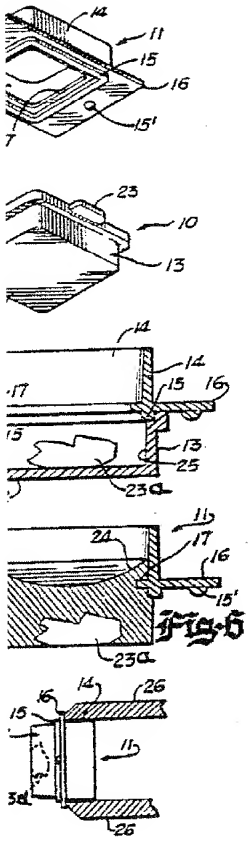

Fig-6

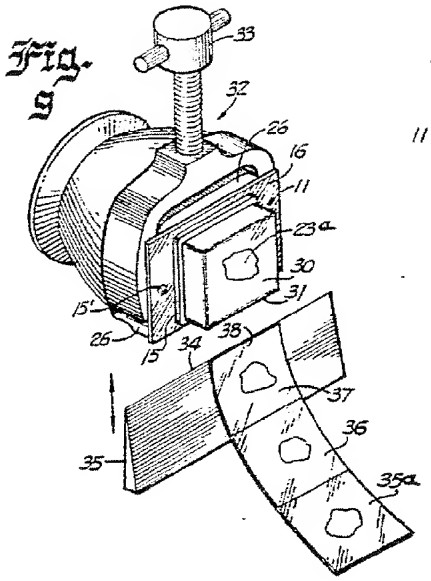

Fig-9

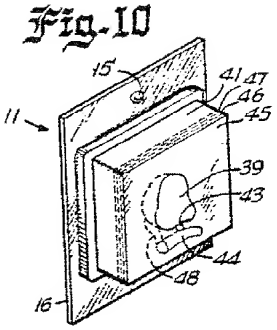

Fig-10

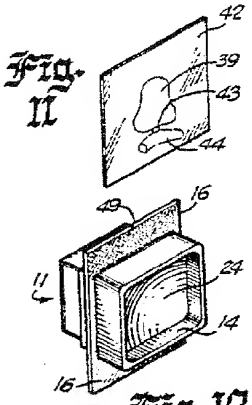

Fig-11

Fig-12

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